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THE RATE OF GROWTH OF PANAEOLUS RETIRUGIS *

By Gertrude E. Douglas

During the last of March, 1906, mycelium of *Panaeolus retirugis*, scattered throughout the pots in the palmhouse of the conservatory in connection with the Department of Botany of Cornell University, began to put forth fruiting bodies in great numbers. As the rate of growth of mushrooms is a matter of some interest, individuals of this species were selected in as early stages as possible and measured twice a day until they had reached maturity. These measurements were taken in the morning and evening at the same time every day, the day interval between them being of eight hours and the night of sixteen. A large number of individuals were measured during the period from March 22 to April 4, but complete records were obtained from only eighteen, owing to the sensitiveness of the mushrooms. A few of them fell over under their own weight, while others were injured by some disturbance of the soil around them. Although great care was taken in using the dividers, some plants, especially in their early stages, were injured by accidentally touching them with the instruments.

The first appearance of the mushrooms above the surface of the soil was a small dark-brown button, from 2 to 3 mm. high and 2 mm. wide. This developed rapidly. The stem grew very fast at first and pushed the pileus up into the air. The pileus at the same time grew rather slowly but steadily, enlarging at about the same rate in all dimensions, the length remaining slightly greater than the width. Just before the stem had ceased its

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period of most rapid growth, the pileus began to increase rapidly in width, gaining at the same time only a little in length. The

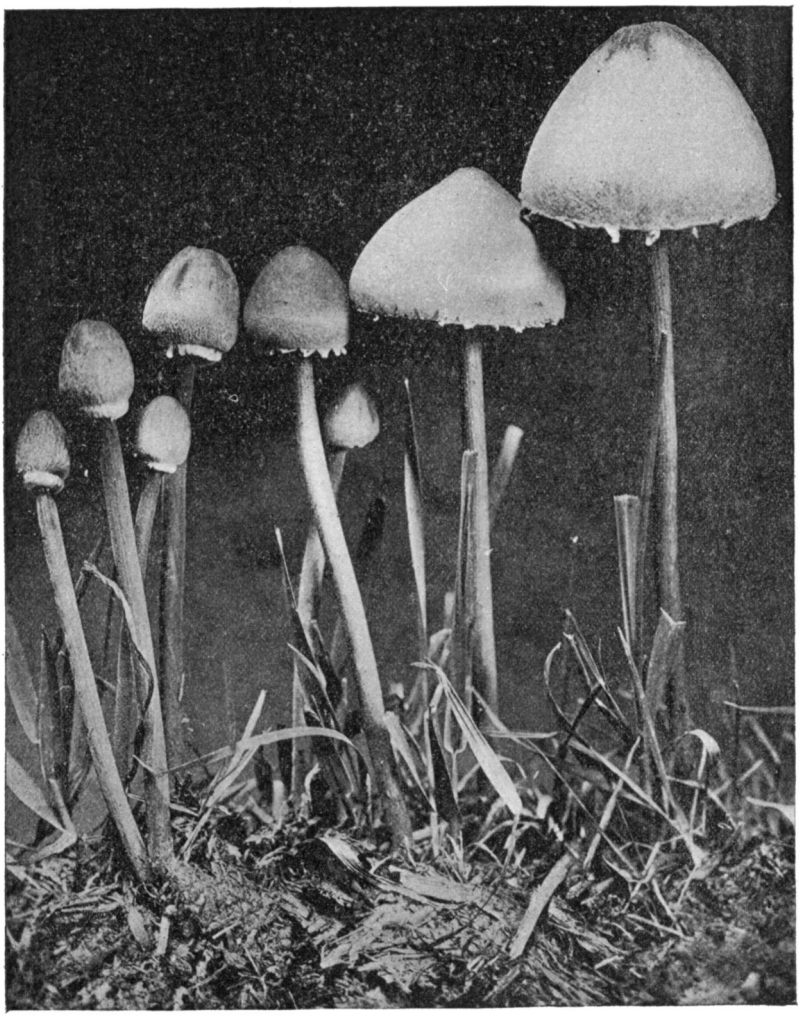

FIG. 1. *Panaeolus retirugis* Fr. A group of plants from a lawn along a street. The young plants at the left show the veil, which breaks into V-shaped loops and clings to margin of the cap. [From Atkinson's Mushrooms, edible, poisonous, etc.]

growth in width sometimes continued one or two days after the stem had ceased to grow. In the early stages, there was a stout

veil, extending from the margin of the pileus to the stem. As the plant developed, this became free from the stem and clung to the margin of the pileus. When the plant had reached maturity, traces of the veil could still be seen in small V-shaped projections clinging to the pileus, as shown in figures 45, 47 and 48 of Atkinson's "Mushrooms, edible, poisonous, etc.," 1903. (FIGURE 1.)

The width of the stem remained nearly the same throughout the growth of the plant. It was slender upon first appearing but it soon increased in diameter, and when the plant was from 10 to 20 mm. high, was as large as at maturity. The color of the plant was dark-brown, until the pileus began to expand laterally, when it became grayish and spotted with brown or black patches. It matured in from 80 to 120 hours after appearing above the ground.

Some of the mushrooms became much larger than others, being at maturity 160 mm. in height, with a pileus of 40 mm. or more in diameter. The majority of the specimens, however, ranged from 120 mm. to 150 mm. in height, with a pileus 30–40 mm. in diameter. Those which became the largest came up nearest the base of the palm or fern trees, due probably to the greater amount of moisture here than towards the edges of the pots. The rate of growth of the eighteen plants, whose records were very nearly complete, has been worked out in curves shown in FIGURES 2 and 3.

As No. A was a very typical specimen, and as the most complete record was obtained of this, I shall describe its growth in some detail. The first measurements were taken in the morning. During the first 8-hour period by day, the plant did not change. However, during the following night, it began to grow slowly until it was 10 mm. high. On the following day, the stem entered on a period of very active growth which lasted about fifty-six hours, until the plant was 145 mm. high. During this period of active growth, the rate at first increased and then decreased slightly. The stem continued growing slowly for sixteen hours after this rapid growth interval.

The pileus began to grow slowly at the same time as the stem. It increased steadily but slowly for sixty-four hours, the width

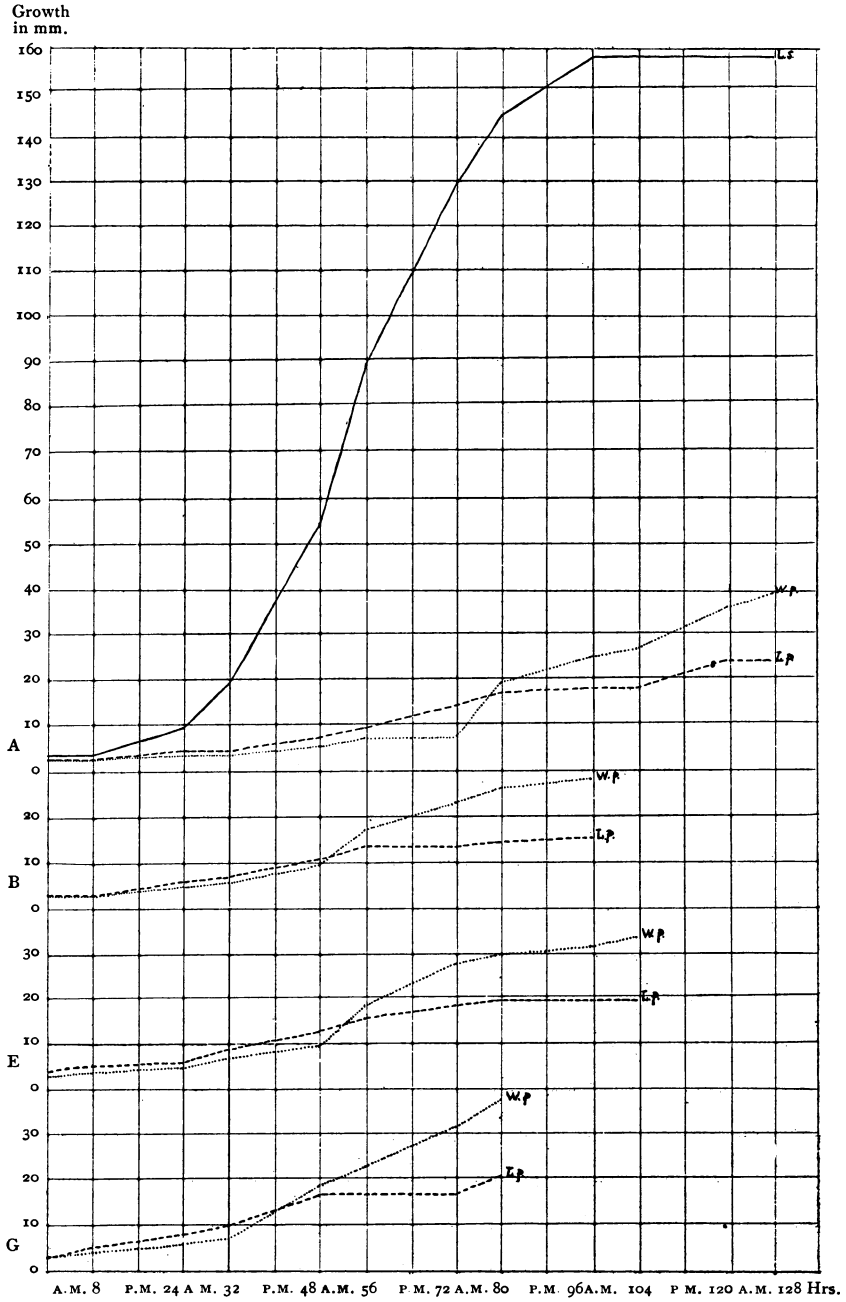

FIG. 2. *Panaeolus retirugis*. Plant A. Curves of a typical specimen showing rate of growth in length of stem and length and width of pileus.

Plants B, E and G. Curves showing rate of growth in length and width of pileus of three other specimens

remaining slightly less than the length. During the last day of the most active stem growth, the width of the pileus made a rapid increase, from 8 to 20 mm. and continued broadening for 32 hours, after the stem had ceased to grow, until it reached 40 mm. At the same time the length continued increasing slowly till it reached 25 mm.

The plant was growing six days and five nights, after its first appearance above the soil. The growth appeared to be no more rapid by night than by day. This was true also of the other specimens measured. In plant A the greatest growth which took place in any one period was during the third day. In the other plants, it occurred sometimes by day and sometimes by night.

The growth of the other specimens was very similar to this one, which has just been described. Of the records of other young plants, although their measurements were not started as early as in A, several (B, D, F, G, H, I) show an interval of slow growth at first. In records from other plants, which were not completed, because of some injury to the plant, this was also the case. After this short period of slow growth, the stem curves show a period of very rapid growth, lasting from forty to fifty-six hours. In some of the plants (P, B, H, T) the rate was nearly constant throughout the interval. In others (A, E, G, F, I, H) the rate increased up to a certain time and then decreased somewhat. In a few mushrooms (C, O, T) the curves are quite irregular, showing abrupt changes in succeeding intervals.

This period of very rapid growth was followed by another interval of slow growth, lasting about twenty-four hours, after which growth ceased. In E, F, G and B the rate was slow and steady for twenty-four hours. In the remaining plants, the curves are irregular showing slow growth at first, followed by a rapid increase in rate. Plant N gained only 1 mm. during twenty-four hours and 9 mm. during the next eight hours. Growth usually ceased abruptly after this period although in a few cases it continued to increase slightly while the pileus was developing.

The pileus of all the specimens developed very much as in plant A. In FIGURE 2, curves of three other plants are given,

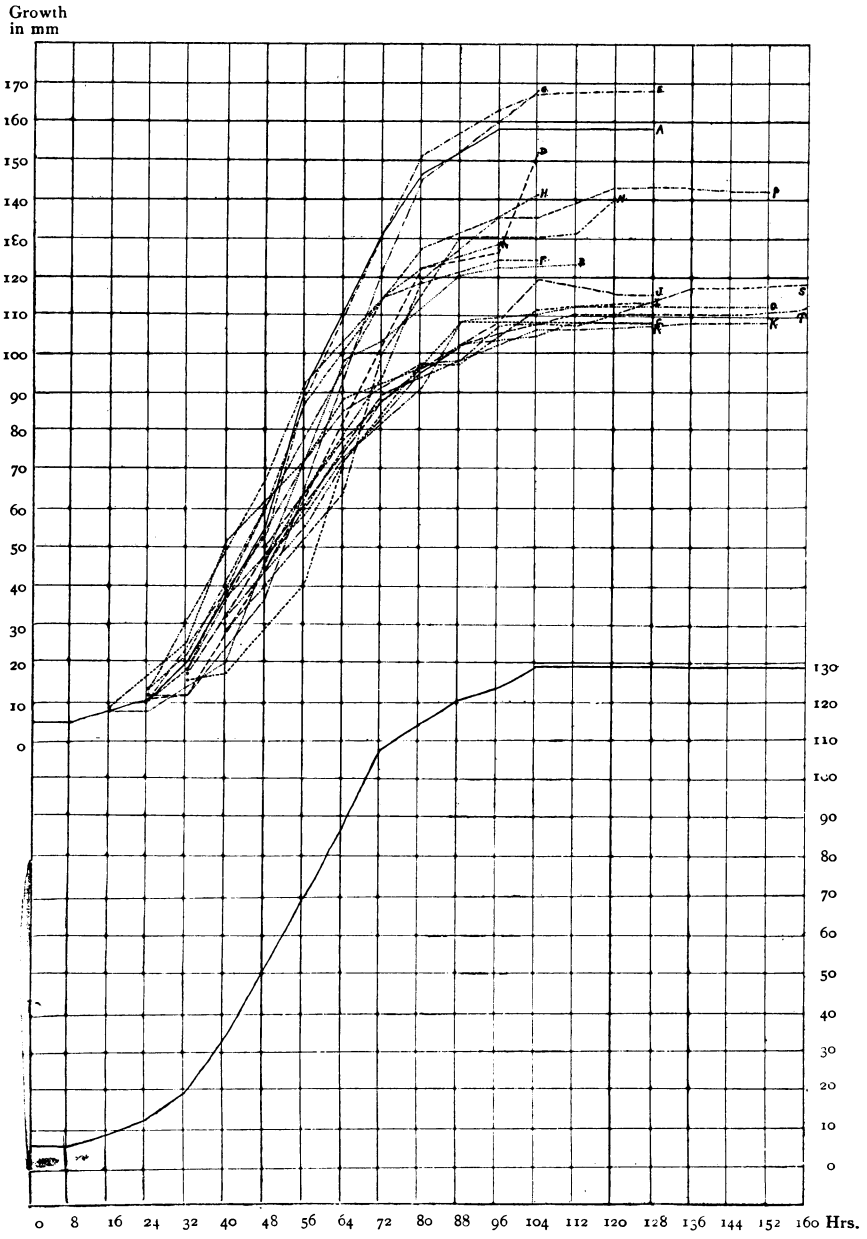

FIG. 3. Curves showing rate of growth in stem of eighteen plants of *Panaeolus retirugis*. Resultant curve beneath.

which are typical of them all. It began its growth with the stem and enlarged gradually, the width curve closely following just beneath the length curve. Suddenly the width curve crosses above the length curve. This usually takes place in the last interval before the stem ceases its most active period of growth. In four cases it did this sooner. The length curve still continues at about the same rate while the width curve keeps on at its increased rate. In some cases the rate is nearly constant, but in others somewhat variable.

The pileus often continued growing after the stem had ceased to elongate; and even when it had begun to dry and decrease in length (J, P). In O it enlarged for as many as forty hours after the stem had stopped its growth.

The width of the stem was at first about 2–3 mm. It soon increased to 3 or 4 mm. when it began to elongate. It remained of the same width until the plant was mature. Before maturity was reached, the stem in some cases decreased about 1 mm. in diameter, due to the drying of the cells in the parts which had ceased to grow.

A few plants were marked to determine in what region of the stem the greatest growth took place. A section of the pileus was cut off in each case so that the whole stem, from the ground to the point where it joined the pileus, might be taken into account. The marks were placed 2 mm. apart. The marked mushrooms were very sensitive to injury and for this reason I was not able to get records more than three times from each plant. The records show that the greatest increase in length took place near the top of the stem (see FIGURE 4). It was usually not in the topmost interval, but in one or two down from the top, near the margin of the pileus. The plants grew for several intervals down the stem, but no growth took place in the lowest ones.

These results in regard to the position of growth in the stem are similar to those obtained by J. Schmitz * in 1841, from the Hymenomycetes. He divided the stem into thirds and found the

* J. Schmitz. "Mycologische Beobachtungen als Beiträge zur Lebens- und Entwickelungsgeschichte einiger Schwämme aus der Klasse der Gastromyceten und Hymenomyceten." Linnaea **16**: 141–215. 1842.

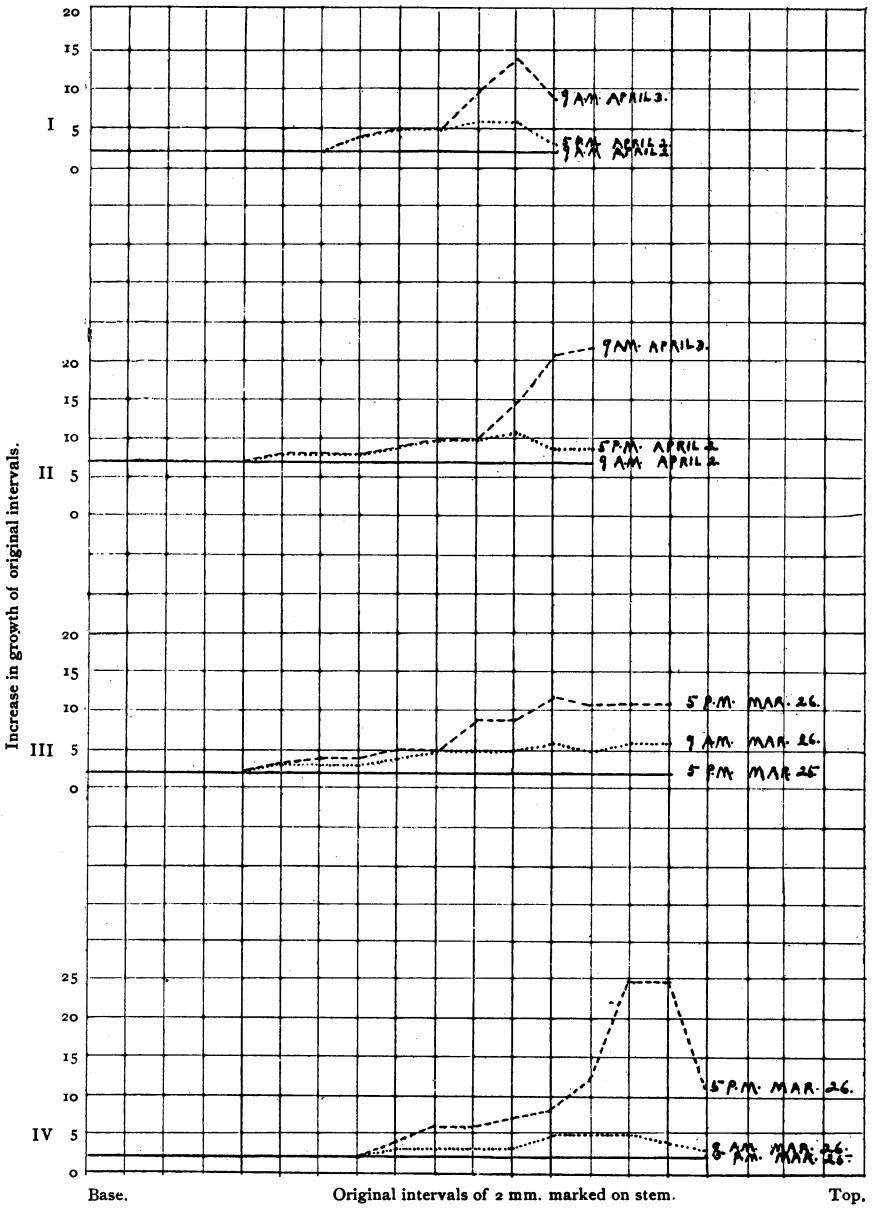

FIG. 4. Curves showing rapidity of growth in different parts of stem of *Panaeolus retirugis*.

greatest growth to take place in the topmost third, less growth in the middle third, and very slight or no growth in the bottom third. In some plants he divided his topmost interval into two parts and found that in many cases the topmost half grew less than the one beneath, although there were a great many variations from this.

In conclusion, the typical *Panaeolus retirugis*, grown under green-house conditions, requires from 4 to 5 days for the complete development of the fruit body after appearing above the ground. The stem grows slowly at first, then very rapidly for from 40 to 56 hours, then for about twenty-four hours slowly again until it ceases.

The pileus grows slowly but steadily at first and enters on its most active period of growth just before this ceases in the stem. The width remains slightly less than the length until this time. It now broadens more rapidly and continues increasing at this rate while the length increases only slowly. The pileus in many cases continues its expansion after the stem growth has been completed.

Growth is no more rapid by night than by day. The growth region of the stem lies near the top, the greatest growth taking place a few mm. below the top of the stem.

This work was undertaken at Cornell University, under the direction of Professor G. F. Atkinson, to whom I am indebted for many helpful suggestions and for the use of photographs of the developing *Panaeolus retirugis*.

ITHACA, NEW YORK,
July 7, 1906.

BOSSEKIA OR RUBACER

BY P. A. RYDBERG

Dr. Greene * has replaced my generic name *Rubacer* by *Bossekia* Necker.† I wish to make a protest, not so much against the replacement of the name as against the spirit and manner in which

* Leaflets 1 : 210. Ap 1906.
† Elem. Bot. 2 : 91. 1790.